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EFFECT OF CECECTOMY ON FEEDING AND DEFECATION IN RATS

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Abstract. The effect of cecectomy on food intake and defecation was studied in Wister rats fed *ad libitum* or under restriction. Food intake, fecal output, dry matter and water content of feces, and numbers of scybala increased significantly in both groups of cecectomized rats. The weight of scybala and their dry matter and water content also increased after cecectomy. Water intake did not change significantly. It was considered that changes in the parameters after cecectomy may have resulted from lowered digestion and enhancement of propulsive activity in the gastrointestinal tract.

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The rodent has a relatively large cecum. The cecum is a site of vigorous microbial activity where indigested food residues as well as endogenously secreted proteinaceous materials are subjected to fermentation, yielding various intestinal gases and ammonia. In these animals, it has been reported that resection of the cecum caused lowered digestibility and increased gastrointestinal transit of the luminal contents (1, 2), and that the gastrointestinal transit rate was a function of the size of the cecum (3, 4).

In the present experiments, the role of the cecum in eating, fecal evacuation and scybalum formation in the proximal colon was studied in rats fed a standard diet *ad libitum* and with restriction.

MATERIALS AND METHODS

Male adult rats of the Wister strain weighing from 250 to 500 g were used. All rats were housed individually in metabolism cages (22 × 40 × 20 cm), and feces and urine were collected separately. All rats were allowed an adjustment period of at least 2 weeks. The cages were close to each other in the same isolator room, and thus exposed to the same light-dark cycles and the same ranges of temperature and humidity.

A standard laboratory chow (Oriental Yeast Co. LTD. Tokyo), with a gross energy content of 359.9 kcal/100 g was fed in solid form. During *ad libitum* feeding (AF) the animals were provided with a weighed excess each day and the amount consumed was calculated from the remainder. For restricted feeding (RF), a known daily quantity was supplied ; usually there was no residue. Rats were allowed to drink water *ad libitum.*

Food and water intake, fecal output, and number of scybala were determined once a day at 5 : 00 p.m. Scybalum weight was calculated from the number of scybala and total weight

of the feces. After feces were dried at 80 ℃ for 24 h, their dry weight was measured, and the mean dry weight of one scybalum was estimated. Water content of feces and scybala were calculated from the weight difference between the wet and dry forms. The rats were weighed every day at 5 : 00 p.m.

Animals were fed *ad libitum* for 10 days and then provided food in restricted amounts for 6 weeks. Thereafter, animals were again fed *ad libitum* for 10 days. A cecectomy was performed on the first day of the 4th week of restricted feeding. Rats were anesthetized with an intraperitoneal injection of pentobarbital sodium (30 mg/kg). Laparotomy was performed along the midline of the abdomen. The cecum was brought out through a gauze swab. In sham-operated animals, it was immediately replaced into the abdominal cavity. Cecectomy was performed by the technique descrived by DeKlerk (5). All animals ate and drank after recovery from anesthesia, and feces were evacuated. In all 10 cecectomized animals good passage of contents through the ileo-colonic junction was maintained.

RESULTS

Mean daily changes in food and water intake, weight of feces and scybala, number of scybala, weight of dry matter in feces and scybala, and body weight in 10 rats during AF and RF before and after cecectomy are shown in Fig. 1. Ten-day means ± SD of water content of the feces and scybala during AF and RF before and after cecectomy are summarized in Table 1. In RF experiments,

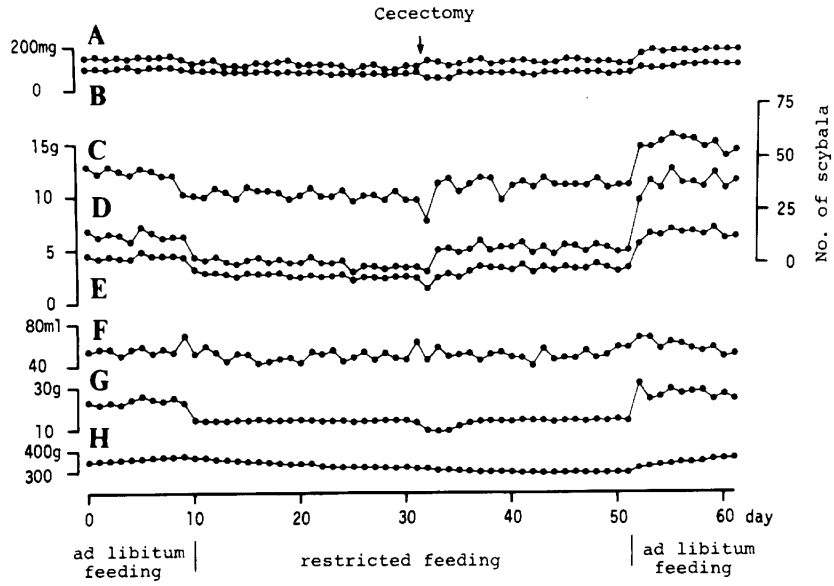

Fig. 1. Daily changes in food and water intake, fecal output, scybalum formation and body weight before and after cecectomy in 10 rats fed *ad libitum* and restrictedly. A and B, wet and dry weight of scybala ; C, number of scybala ; D and E, wet and dry weight of feces ; F and G, water and food intake ; H, body weight.

the values of each parameter were obtained from the data for 10 days just before cecectomy and from 11th to 20th day after the operation.

Change in parameters in the intact rats. In individual rats, fecal output and numbers of scybala during AF and RF were comparably stabilized, though at different levels. They diminished with decreased food intake. Rats evacuated less fecal matter and smaller numbers of scybala during RF than during AF. Dry matter of the feces also diminished with decreased food intake, but the percentages of dry matter in the feces relative to food intake did not change according to the amount of food intake. These percentages were 18.9 % and 18.3 % in AF and RF, respectively. Numbers of scybala decreased and the size of scybala, which corresponded to their weight, became smaller when food intake and the fecal output decreased. Body weight decreased during restricted feeding.

TABLE 1. EFFECT OF CECECTOMY ON 10 PARAMETERS DURING *AD LIBITUM* AND RESTRICTED FEEDING (MEANS ± SD ESTIMATED FROM DAILY VALUES FOR 10 DAYS IN 10 RATS).

	Ad libitum feeding		Restricted feeding	
	Control	Cecectomy	Control	Cecectomy
Food intake (g)	23.8 ± 1.4	27.9 ± 2.3*	14.8 ± 0.2	14.9 ± 0.2
Number of scybala	43 ± 2	57 ± 3 *	32 ± 2	37 ± 2 *
Weight of feces (g)	6.6 ± 0.4	11.6 ± 0.8*	3.8 ± 0.4	5.4 ± 0.4*
Dry matter (g)	4.5 ± 0.2	6.7 ± 0.5*	2.7 ± 0.2	3.5 ± 0.2*
Water contents (g)	2.1 ± 0.3	4.8 ± 0.5*	1.1 ± 0.3	1.8 ± 0.2*
Weight of a scybalum (mg)	154 ± 5.8	199 ± 10.0*	124 ± 7.8	149 ± 9.4*
Dry matter (mg)	108 ± 3.3	122 ± 5.0*	90 ± 2.5	103 ± 5.8*
Water contents (mg)	47 ± 4.8	77 ± 7.6*	35 ± 7.2	50 ± 6.9*
Water intake (ml)	57.3 ± 5.0	60.0 ± 6.0	51.5 ± 3.8	52.8 ± 5.9
Body weight (g)	364.6 ± 7.9	349.9 ± 17.2*	327.2 ± 4.7	303.0 ± 0.8*

* $p < 0.01$, $n = 10$

Effect of cecectomy on rats fed ad libitum. Rats ate more chow after cecectomy. The daily food intake was 23.8 ± 1.4 and 27.9 ± 2.3 g before and after cecectomy. respectively ; the difference was significant ($p < 0.01$). Body weight significantly decreased from 364.7 ± 7.9 g before cecectomy to 349.9 ± 17.2 g after cecectomy, because rats were allowed to eat only small amounts of food during the 6 weeks of RF. The food intake per 100 g of body weight was 6.5 ± 0.3 and 8.0 ± 0.9 g before and after cecectomy ($p < 0.001$). Weight of feces, dry matter of feces and numbers of scybala increased by 75.8, 48.9 and 32.6 %, respectively, after cecectomy ($p < 0.01$). Accompanying the increase in fecal output, water content of feces and scybala after cecectomy became higher than in the control (41.3 vs 31.8 % in feces and 38.7 vs 30.5 % in scybala, $p < 0.01$). Weight of scybala after cecectomy was about 1.3 times that before the operation. The percentage of dry matter in the feces relative to food intake increased from 18.9 % before cecectomy to 24.0 %

after cecectomy. Water intake of the rats did not change during the experiment either with or without cecectomy.

Effect of cecectomy on rats given restricted amounts of food. In this series of experiments rats were given 15 g of chow once a day, and they ate almost all of the chow except for the powder. Rats ate less than 15 g of food just after the cecectomy, but food intake recovered within a week. The 10-day means of food intake were 14.8 ± 0.2 and 14.9 ± 0.2 g before and after the cecectomy, respectively.

Fecal output decreased on the first day after cecectomy and then recovered within a few days. Ten-day means of feces weight increased by 42 %, of fecal dry matter by 29.6 %, of fecal water content by 63.6 %, and of number of scybala by 15.6 % after cecectomy ($p < 0.01$). The ratio of dry matter content in feces to food intake also increased from 18.3 % before cecectomy to 23.5 % after the operation, although the weight of food intake did not change. Mean weight of scybala, and dry matter and water content of scybala also increased after cecectomy ($p < 0.01$), while there was no significant difference in the water intake. Body weight decreased after the cecectomy ($p < 0.01$).

Effect of sham-operation on the rats given restricted amounts of food. The effects of sham-operation on 10 parameters were studied in three rats fed restrictedly. In one rat, there was no significant change in any of these parameters before and after the operation, while in the other two, the parameters, except for water intake, all decreased after the sham-operation.

DISCUSSION

Fecal output increased with an increase in food intake in intact rats, while resection of the cecum resulted in greater fecal output and food intake in the rats fed *ad libitum.* Such a correlation between food intake and fecal output has been reported in intact guinea pigs (6). However, an increase in fecal output observed after cecectomy in the present experiment was due not only to an increase in food intake but also to the altered function of the gastrointestinal tract (motility, digestion and absorption), since fecal output increased after a cecectomy during RF but did not change after a sham-operation. Dreyer *et al.* (1) measured fecal weight and food intake before and after cecectomy in rats to study the effect of cecectomy on the gastrointestinal digestibility. Although they did not note any change in fecal output and food intake, their data showed that fecal output increased in spite of no change in food intake after cecectomy. It was also reported that the weight of feces in mice increased after cecectomy (7).

Much more dry matter than in intact rats was evacuated in feces and scybala after a cecectomy, even when the rats were fed restricted amounts of food. An increase in water content of the feces and scybala was noted in the cecectomized rats fed *ad libitum* as well as in those fed a restricted diet, although water intake did not change significantly.

From the above results it may be concluded that cecectomized rats evacuated more scybala containing greater amounts of dry matter and water than those in intact rats. Possible explanations are that the functions of the cecum, such as digestion, absorption and reservior action on the intraluminal contents, are lost after a cecectomy, and that digestibility of organic matter, crude protein, and carbohydrates in the gastrointestinal tract decreases significantly in cecectomized rats (1, 2). On the other hand, the movement of intraluminal contents in the gastrointestinal tract as measured by the time for the appearance of radioactive chromium in feces, is faster in cecectomized rats than in sham-operated animals (2). Abrams and Bishop (3) showed that gastric emptying, and small intestinal, cecal and colonic transit was faster in conventional rats than in germfree rats having an enlarged cecum, although both rats ate the same amount of food. They suggested that propulsive activity of the gastrointestinal tract may be enhanced in conventional rats. Iwai *et al.* (4) showed that in mice in which the cecal size was varied by manipulation of the gut microbial flora, the bigger the cecum was, the slower was the transit of chromium sequioxide through the small intestine. These authors concluded that microbial flora may accelerate the gastrointestinal transit rate. It may be, however, that not only microbial flora but also the size of the cecum may affect the gastrointestinal motility, since acceleration of propulsive activity, or the transit rate may result from the lack of an inhibitory influence on the stomach and small and large intestine, which can occur tonically by extrinsic reflex from the cecum. Cecal distension caused an inhibition of gastrointestinal motility, and the stronger the distension was, the greater the inhibition of the motility was (Itano and Neya, unpublished data). Thus, resection of the cecum causes an enhancement of gastrointestinal motility and a lowering of digestibility, resulting in a larger amount of contents being transferred into the colon in cecectomized rats. Water absorption in the colon was not significantly different between rats undergoing a cecectomy and those not (7). Thus, volume of feces evacuated, dry matter and water content of the feces and scybala were larger in the cecectomized rats.

A larger size and number of scybala were formed in cecectomized rats than in intact ones. It has been shown that scybala are formed from chyme by tonic constriction rings repeatedly occurring in the proximal colon oral to a pacemaker (9). Although the mechanism initiating constriction rings is not yet known, constriction rings appear more frequently as more material flows continuously into the proximal colon in cecectomized rats because of the loss of the reservior function of the cecum and the increase in the gastrointestinal transit rate. Therefore, scybala formed in cecectomized rats may be larger in number and size.

Cecectomized rats ate more than intact animals. This may be a response to the lowered digestibility of organic matter (2, 10) or to a decrease in the sensitivity of the satiety center of the hypothalamus (2).

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